Food web subteam meeting #1
November 6, 2014
DWR West Sacramento noon-3pm

1. Attendees: Rosemary Hartman, Alice Low, Stacy Sherman, Trishelle Morris, Bruce Herbold, Larry Brown(USGS), Jan Thompson (USGS), Gardner Jones (DWR), Anitra Pawley (DWR), Hildie Spautz (DFW), Tiffany Brown (DWR), Heather Fuller (DWR), Betsy Wills (DWR), Krista Hoffman (DWR), Kelsie Cowen (SFWCA); Peggy Lehman (DWR)
2. Overview of PWT process – develop generalized plan for monitoring restoration sites in Delta and Suisun Marsh, with focus on salmon and smelts, but also their food, competitors, and predators.
3. Review of conceptual models – based on DRERIP models, but focused on tidal wetlands specifically. Major aspects of food web model: zooplankton and their phytoplankton food, but also detrital loop, macroinvertebrates, and clam influence on plankton biomass.

Food web subteam hypotheses

- **PREMISE 2.2:** Restoration of tidal wetlands will increase food web support for Salmon and Smelt on the landscape scale.
  - **Hypothesis 2.2.1**: Long term monitoring will show increases in phytoplankton and zooplankton across the estuary relative to pre-project conditions.
    - **Potential Monitoring Metrics:**
      - IEP monitoring – zooplankton collected in conjunction with long-term fish monitoring (FMWT, townet, etc)
      - IEP zooplankton monitoring (EMP http://www.water.ca.gov/iep/activities/emp.cfm)
      - IEP phytoplankton monitoring (EMP)
    - **Issues raised during discussion:**
      - This will be very noisy and difficult to prove, it may ultimately not be useful.
      - It is possible that we increase productivity but will not be able to detect the signal because the fish (or clams) eat it all
      - John Durand suggested estimating fecundity or growth rates of plankton may help tease apart productivity and biomass.
      - Jim Hobbs points out that long-term monitoring is often not done all that close to restoration sites, and the tide stage will determine whether we see a signal from a nearby restoration site.
  - **Hypothesis 2.2.2:** There will be an increase in marsh-derived carbon in juvenile Salmon and Smelt tissue found throughout the estuary relative to pre-project conditions.
    - **Potential Monitoring Metrics:**
      - Stable isotopes
    - **Issues raised during discussion:**
      - Stable isotopes will tell you whether carbon from macrophytes gets into the fish, but not phytoplankton from open water parts of your estuary
      - Stable isotopes will be messy with salmon and smelt, which are usually transient species, not residents

- Jim Hobbs (isotope expert) points out There "may" be a consistent isotope fingerprint that will be unique to marsh derived carbon, but yet it's messy which means we really don't have a good handle on the variability. There are some experimental ways to deal with using isotopes such as spiking certain sites/restoration with rare isotopes to artificial create a unique isotope ratio. I can imagine this being an FDA issue since salmon get consumed, but we are talking juveniles so its possible.
- Bruce brought up the fact that we expect phytoplankton production to be highest when fish are not there. Others pointed out that this is how the system works now, but we should expect the unexpected.
- We decided to re-address these hypotheses after we have ironed-out the site-specific hypotheses
- Rosie still thinks it's valuable to state these hypotheses even if they will be very difficult to prove/disprove, because it is the premise behind the Biological Opinions all this restoration is based on.

❖ **PREMISE 5.1:** Restoration of tidal wetlands will increase primary and secondary production on site.

➢ **Hypothesis 5.1.1** Nutrient ratios, species, and concentrations may influence primary producer communities

▪ **Potential metrics:**
- Nitrogen (organic and inorganic, all species: NH4, NO3, NO2)
- Phosphorus (organic and inorganic)

▪ **Issues raised during discussion**
- There still isn't consensus in the scientific community as to whether nutrient ratios and species influence phytoplankton communities

➢ **H5.1.2** Restoration landscape and site attributes will drive the magnitude and type of primary production on the site.

▪ **Metrics**
- Phytoplankton biomass, size structure and composition
- Epibenthic algae
- Epiphytic algae
- Macrophytes
- Harmful algal blooms – species identity and toxicity

▪ **Issues:**
- Restoration trajectory (comparisons of a single site over time) may be a better way to think about this than comparisons to other sites, however if you do not compare between sites it is difficult to determine the "why" of the outcomes.
- This hypothesis will be adapted to a specific site to relate how the landscape features and restoration action result in different forms of primary production.
- Tailoring this to a particular site may mean some things you will not measure at all sites e.g., if you only have five blades of tule, you don't need to measure epiphytic algae
- Jim Hobbs says "I really don't forsee us monitoring epiphytic algae invertebrates…..otherwise we would already be doing it on a consistent basis. We did this with Fred Feyrer and Louise Conrad in the delta on a couple projects. That study should be able to give us an idea what to do and how often. "

- **Hypothesis 5.1.3:** Form and magnitude of primary production, along with site and landscape attributes, will drive form and magnitude of secondary production:
  - **Sub-hypothesis** 5.1.3.1 If the site has increased emergent vegetation, it will also have increased biomass of epiphytic invertebrates, and detritus.
    - **Metrics:**
      - Area of and composition of vegetation
      - Detritus (particulate organic matter)
      - Biomass of epifauna (invertebrates)
    - **Issues:**
      - We discussed whether we wanted to separate the epiphytic algae and invertebrates from the detritus. I left them together, but let me know if it seems weird to you.
  - **Sub-hypothesis** 5.1.3.2 If restoration sites have increased pelagic primary production, they will have increased pelagic secondary production.
    - **Metrics**
      - Zooplankton biomass
      - Other invertebrate biomass (esp. mysid shrimp)
    - **Issues:**
      - We want to suggest tiered monitoring. Some stuff will be monitored all the time, some will only be monitored if needed or if a particular site has specific questions.
  - **Sub-hypothesis** 5.1.3.3 Site attributes will determine the form and extent of benthic invertebrate production
    - **Metrics:**
      - benthic invertebrate biomass (amphipods, chironomids, and other high food-value organisms)
      - benthic invertebrate community composition
    - **Issues:**
      - Benthic primary production is hard to measure, so we may suggest just doing secondary production and do primary production (benthic microalgae if you have extra $$ or specific questions)
      - Bruce advocated putting benthic grazers as part of this hypothesis, but other people liked separating it out because we are interested in fish food in this hypothesis, whereas we are interested in competition with fish in the clam hypothesis.
      - John Durand points out benthic inverts are doing quite well in most places, it may be better to tie this hypothesis to substrate or other site attributes
      - Jim Hobbs says "We actually have no idea whether there are more or less benthic inverts, I think John is pointing out they are common, but his statement has not long term perspective. I think quantify the benthic invert diversity, abundance composition is probably the most reliable metric to produce that can be specifically tied to the restoration. "
      - Even the more mobile benthic inverts (amphipods, shrimp) may be quite hard to sample effectively. UCD does an index of abundance relative to trawled debris. Can also do traps, maybe smaller meshed trawls. Design devices we

Comment [RKH1]: Salinity, substrate, hydrodynamics, etc, will also affect secondary production.

outplant that will attract bugs….like benthic invert hotels that we can retrieve and sample. Won't be that hard.

- Distinguish benthic from epi-benthic... Things that would require coring or ponar grabs of sediment versus what could be swept from the bottom in a net or pump.

- **PREMISE 5.2**: Increased production will lead to increased food supply for at-risk fish species both on-site and in adjacent open water channels.
  - **Hypothesis 5.2.1** Zooplankton community composition and size structure will affect fish diet and diet efficiency
    - **Metrics:**
      - Zooplankton community composition and size structure
      - Fish diet composition
    - **Issues:**
      - We want to see what trophic level the fish are eating at, and how many trophic levels the carbon had to go through
      - We don't want carnivorous zooplankton to dominate
      - One thing we may consider here is being able to sample at the scale fish actually encounter prey. I feel like we could be mislead by the way we sample pelagic production with nets. Zooplankton are highly aggregated. There are ways to sample at small scales that are more reflective of what a fish would encounter like pumps with small intakes. This can be time consuming to do and lead to low counts of organisms but we could better tie encounter rates with fish feeding and growth models.
  - **Hypothesis 5.2.2** Increased emergent vegetation will increase the contribution of periphyton, detritus, and other marsh-derived carbon to the pelagic food web .
    - **Metrics:**
      - Fish diet composition
      - Stable isotope analysis
    - **Issues:**
      - Stable isotope studies are hard. We should talk to Emily Howe and Matt Young to make sure we do them right, if we do them at all. May be a special study rather than regular monitoring
  - **Hypothesis 5.2.3:** Fish on, or adjacent to, restoration sites will have higher food consumption relative to pre-project conditions.
    - **Potential Metrics:**
      - Fish stomach fullness
      - Diet composition
      - Fish body condition (length-weight relationship, RNA:DNA)
      - Growth rates
      - Stable isotope analysis?
      - Fatty acid analysis?
    - Issues:
      - There are various ways to get fish condition and growth rate, some more difficult or expensive than others. We can include multiple methods and let individuals choose which works best for their project.
      - However, we also want consistency across sites…
      - . For salmon, they probably move through too quickly for anything other than fullness and diet comp. Smelt we don't have any idea if they will enter restorations…at least

Comment [RKH2]: Do we want to include caloric content or some other measure of food quality?

delta smelt…longfin we have good evidence they do. Tying growth rate to restoration sites will be difficult, but is the primary metric we need to have.

- **PREMISE 6:** Benthic grazers in restored tidal wetland complexes will reduce primary and secondary production available to the food web on-site and in adjacent open water channels.
  - **H6.**1: Benthic grazer biomass will increase within restoration sites relative to pre-project conditions
    - **Metrics:**
      - Benthic grazer biomass
      - Benthic community composition
      - Grazing rates (tied to identity)
    - **Issues**
      - We discussed whether to move this to secondary production hypothesis, but we would rather leave it separate to highlight the competition
      - Changed this from "clams" to "benthic grazers" because other benthic invertebrates are important, eg filter-feeding amphipods, sponges, native mussels (though native mussels will probably never be abundant enough to be a problem)
      - Jellyfish are also a competitor, as well as shrimp, but we will have to research them more before we can figure out where to put them.
      - High zebra mussel biomass has led to ammonia problems, but that hasn't been seen with Potamocorbula or Corbicula
  - **H6.2:** In areas where benthic grazing is high, primary and secondary pelagic biomass will be reduced
    - **Metrics:**
      - Phytoplankton biomass (chl a or carbon)
      - phytoplankton composition and size structure
      - Zooplankton biomass, composition, and size structure
    - Issues:
      - Should we just say biomass here because we said community composition and size structure earlier? No, we should include all the metrics necessary to answer the question, even if we repeat some
- **Premise X:** Other members of the community may act as predators or competitors, which may reduce the food supply, growth, or abundance of at-risk fish species.
  - Hypothesis X.1: Birds are a significant source of predation pressure on fish.
    - Metrics:
      - Bird use of restoration site
      - Species to include: egrets, herons, diving ducks, terns, cormorants, pelicans
      - Bird diet: scat, vomit, ID of fish otoliths in bird poop
      - Motion cameras
    - Issues:
      - Very little has been done in terms of wading bird communities in the Delta.
      - Very little is known about the effect of birds on fish, though lots on the effect of fish prey in wetlands on bird populations/nesting.
      - Could start a citizen-science program for bird watchers to collect data for us

Comment [RKH3]: We had a premise about non-native fish predation, but didn't ever have a premise addressing other predators.

        - Hildie wants to start keeping track of wader nesting colonies
        - Some birds are migratory, some are permanent residents
        - How do we get bird diet? Apparently you can get birds to throw up to look at diet composition.
- Hypothesis X.2: Otters and other mammals (maybe raccoons, muskrat, sea lions) are a significant source of predation pressure on fish.
    - Metrics:
        - Otter population
        - Otter wetland habitat use
        - Otter diet (scat)
    - Issues:
        - Very little research has been done on otters
        - Cynthia LeDoux Bloom has done some research
- Hypothesis X.3: Crustaceans (shrimp, crabs, crayfish) may act as predators or competitors.
    - We need to do more research on this
    - These will be difficult to sample
- Hypothesis X.4: Jellyfish may act as predators or competitors, especially in Suisun marsh.
    - They may eat phytoplankton, zooplankton, or occasionally larval fish

Next steps:

We will want to determine how to measure all of these metrics. The FRP team will produce a revised set of hypotheses and metrics and distribute them a week before the next meeting so members will have time to review and comment on them. We will meet in 2 or 3 weeks (Nov 24th, 25th, or first week in December, Doodle poll to follow)